DYNAMIC ANALYSIS OF ADOBE STRUCTURE WITH BILINEAR MATERIAL MODELLING

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SUPERVISOR'S DECLARATION

I hereby declare that I have checked this project report and in my opinion, this thesis is adequate in terms of scope and quality for the award of the Bachelor Degree of Civil Engineering

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STUDENT'S DECLARATION

I hereby declare that the work on this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

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Thesis submitted in fulfillment of the requirements
for the award of the
Bachelor Degree in Civil Engineering

Faculty of Civil Engineering and Earth Resources

UNIVERSITI MALAYSIA PAHANG

JUNE 2018

ACKNOWLEDGEMENTS

I would like to express my thankfulness to my supervisor Dr. Gul Ahmed Jokhio for his precious advices, guidance, motivation and moral support in making this study possible. I really appreciate his suggestion and encouragement to make me more clear and understand about this study. Without his guidance, my study will be hard to complete this study.

I sincerely warmly appreciated to all of the lecturers and staffs in Faculty of Civil Engineering and Earth Resources (FKASA), who help me during the university life and make me more understand about the civil engineering course especially for the course that related to my study. Furthermore, I would like to thanks to my final year project panels who give me the suggestions and advices during the presentation to make my study more clear and smooth. Furthermore, I also like to give many thanks to my course mates for their moral supports and cooperation during carry out this study. This marks my university life become more unforgettable and meaningful.

In addition, I am really like to give thousands of thanks to my parents. Their love, patience, sacrifices and opportunity to get the education start from small age until now. Without my parent guidance and support, I will not have a great chance to do this final year project. From final year project, I get the opportunity to expand my knowledge that related to this study via journal, internet and books.

Last but not least, I am extremely grateful to any individual who directly or indirectly contributes to my final year project. I appreciate their suggestion and moral supports to complete this study successfully.

ABSTRAK

Struktur adobe sangat terdedah dalam beban dinamik terutamanya beban seismik. Sifat bahan adobe yang sesuai akan menyediakan kekuatan yang cukup untuk mengurangkan kerosakan bangunan adobe dan mengelakkan kematian serta menjimatkan kos penyelenggaraan. Dalam kajian ini, kaedah simulasi akan dijalankan dengan menggunakan perisian analisis unsur terhingga, ANSYS. Kajian simulasi ini akan membentangkan tentang kelakuan struktur untuk struktur model adobe yang mengalami beban dinamik. Tujuan kajian ini adalah untuk mengkaji kelakuan struktur adobe semasa mengalami beban beban seismik.

Dua jenis perbezaan sifat bahan adobe akan digunakan dalam kajian ini iaitu sifat-sifat tidak linear (bata adobe tanpa tetulang) dan sifat-sifat bilinear (bata adobe dengan tetulang wayar mesh). Dalam analisis ini, kelakuan struktur untuk dua bahan yang berbeza seperti pesongan, tekanan dan ketegangan akan dibandingkan. Ia dijangka mendapati bahawa apabila tetulang wayar mesh ditambahkan, kelakuan struktur adobe akan meningkatkan dengan ketara. Ia menunjukkan bahawa sifat-sifat bilinear (bata adobe dengan tetulang wayar mesh) akan menjadi lebih sesuai untuk terhadap beban seismik.

ABSTRACT

Adobe structures are more vulnerable in dynamic loads especially for seismic loads. The proper material properties of the adobe bricks will provide the sufficient strength in order to minimize the damage of the adobe building and also prevent loss of human lives and save maintenance costs. In this study, the simulation method will be used by using finite element analysis software, ANSYS. This simulation study presents about structure behaviors of adobe model structures undergoes dynamic loads. The purpose of this study is to study the structure behaviour of adobe structures subjected to seismic load.

Two types of difference adobe material properties will be used in this study such as nonlinear properties (adobe brick without reinforcement) and bilinear properties (adobe brick with wire mesh reinforcement). In this analysis, the structure behaviour of two difference materials like deflection, stress and strain will be compared. It is expected to find that when wire mesh reinforcement is added, the structure behaviour of adobe improves significantly. It shows that the bilinear properties (adobe brick with wire mesh reinforcement) will be more suitable to against the seismic load.

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CHAPTER 1

INTRODUCTION

1.1 BACKGROUND OF STUDY

Adobe is made of sun-dried earth bricks also known as dried mud bricks. Adobe is the earliest building material in use because it is easy to procure and the cost is cheaper. Nowadays, the adobe structures are widely used throughout the world especially in the Spainish region, South Asia, Central Asia, Middle East, Africa, Peru and East Europe.

The adobe material has brittle characteristic and it has higher compression strength compared to its tensile strength. There are a few advantages and disadvantages of using adobe bricks. First of all, adobe bricks are cost effective and environment friendly compared to concrete material. This is because concrete is mixed with cement which produces carbon dioxide that causes the greenhouse effect; adobe does not produce carbon dioxide since it is made from earth. Adobe materials have low energy usage compared to other materials. In addition, adobe bricks have high fire resistance, high durability, and high resistance to sound transmission. The main disadvantage of adobe bricks is that these materials are very weak against tensile stresses especially due to earthquake or seismic load. Furthermore, making adobe structure is time consuming and the labor cost is high. However, in some parts of the world where unemployment is high, this is considered an advantage as it creates more jobs. Adobe structures are not suitable for the regions that have excessive rainning, this is because the adobe structures are easy to break when mixed with water.

The seismic load is the major issue for adobe structures especially in South Asia, Central Asia, Middle East, Africa, and East Europe. Therefore, the properties of adobe need to be improved to prevent this issue. In a recent study, it was found that adding wire mesh reinforcement changes the material model to bilinear. In this study, the

ANSYS software will be used to model the adobe structure with bilinear material modelling. After making the model, it will be subjected to seismic load in order to assess the behaviors of adobe structures.

1.2 PROBLEM STATEMENT

In general, the adobe structures are built in the rural areas of these regions, which are Spain, Mexico, South Asia, Central Asia, Middle East, Africa, and East Europe. These buildings are more environment friendly compared to using concrete as building material.

There are some major downsides to adobe structures when subjected to seismic load. In this study, the structure behaviors of adobe against seismic load will be studied. Adobe structures are weak against seismic load, this is because abode material has low strength compared to concrete, has brittle properties, and is weak in shear and tension. This can cause severe damage to the building and loss of residents' lives. In 2001, an earthquake occurred in the south of Peru which caused the death of 81 people, the destruction of almost 25,000 adobe houses and the damage of another 36,000 houses, with the result that more than 220,000 people were left without shelter. In the same year, an earthquake happened in El Salvador, which caused more than 200,000 adobe buildings to be severely damaged or collapsed, 1,100 people died under the rubble of these buildings, and over 1,000,000 people were made homeless (EERI/IAEE World Housing Encyclopedia , 2003).

1.3 OBJECTIVE

1) To model the adobe structure behavior using bilinear material model.

2) To study the behaviors of adobe structure subjected to seismic load.

1.4 SCOPE OF STUDY

This study is based on analytical study which consists of modelling and simulation. The ANSYS software will be used in this study. The materials properties that will be used to model the adobe structures are linear, non-linear and bilinear. After designing the adobe structures, the same model will be subjected to static and dynamic analysis. Then, the results of different models will be compared with each other and with literature. In this study, two models with different material properties such as non-linear and bilinear with 3D solid element will be analysed. The analysis type that will be used in this study is dynamic time history analysis.

1.5 EXPECTED OUTCOME

The expected outcome of this study is to achieve adobe structure modelling with bilinear material properties and normal material properties. At the same time, we understand about the structure behaviors of different type of material properties of adobe structures modelling when withstand to seismic load. It is expected to find that when wire mesh reinforcement is added, the structure behavior of adobe improves significantly.

1.6 SIGNIFICANCE OF MY STUDY

The finding of this study will be helpful in understanding the behavior of adobe subjected to seismic load. This will also help improve the mechanical properties of adobe for stronger and efficient construction. This study is important because it will prevent the severe damage of residents' lives and building and also minimize the maintenance cost to the adobe structure.

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